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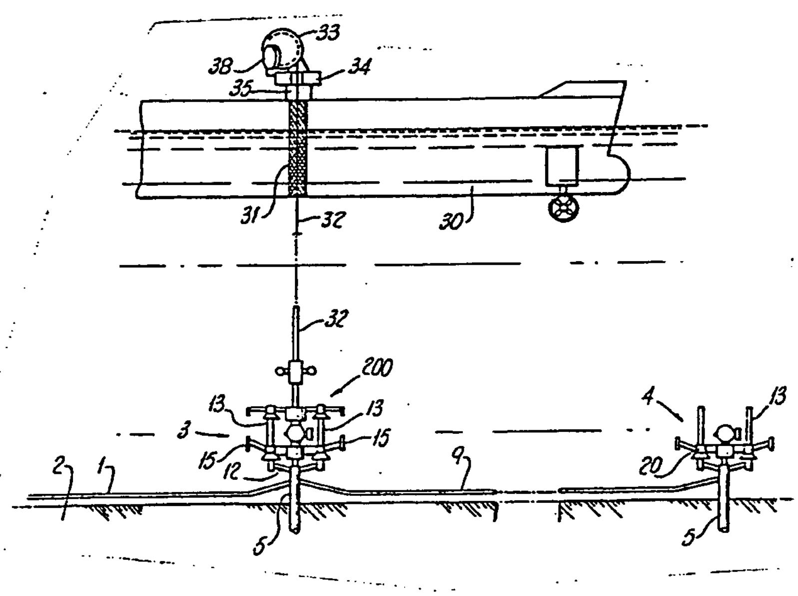

(57) Abstract

A method and a system for loading a tanker (3) with oil or gas from a submarine conduit (1), wherein the tanker is positioned dynamically above a coupling structure (3) connected to the conduit (1), and wherein a riser pipe (32) is lowered from the tanker, the lower end of said riser (32) carrying a coupling means (211) which is coupled to the coupling structure (3). The lower end of the riser (32) is positioned dynamically during the lowering and coupling operation by means which are monitored by the dynamic positioning system of the tanker, the position of the lower end of the riser being controlled by the dyamic positioning system of the tanker during the controlled lowering of the riser, and the lower end of the riser being precision regulated by a precision regulation system which is integrated in said dynamic positioning system. The overall dynamic positioning system also includes a heave compensation system (33, 38) which aside from being used during the loading operation, can also be used during the initial lowering and the final coupling phase of the riser coupling means (211).

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Method and system for loading a tanker with crude or gas from a submarine terminal.

Field of the Art

The present invention relates to a method and a system for loading of a tanker with crude or gas from a seafloor terminal.

Background of the Invention

Conventional offshore loading systems are based on conducting the hydrocarbons from a seafloor pipeline up through the ocean surface by anchored buoys or articulated towers. In such cases the structures of such systems which are present at sea surface, represent significant investments. The shuttle tankers transporting the hydrocarbons to an appropriate installation on shore are normally anchored to the offshore loading facility by means of hawsers or the like.

The hook-up of the shuttle tanker to the surface offshore loading facility cannot be performed in too adverse weather, and is usually limited to 4.5 to 5.5 m significant wave heights. This pertains also to systems where the shuttle tanker is connected direct to the riser instead of to the offshore loading facility, by means of hoses floating at the surface. By connection directly to the riser pipe there will be problems with loads transferred to the riser. For this reason some proposals are known for the arrangement of the riser and its connections to the shuttle tanker and the seafloor pipeline, respectively.

Brief Statement of Prior Art

Reference is made to Norwegian printed publication No. 136 243 disclosing an articulated riser system, whereas

GB patent specification No. 1 198 950 and Norwegian patent application No. 78 0119 outline systems for the connection between a riser pipe an a shuttle tanker allowing the vessel to move.

In order to reduce the problems of connection operations at the surface, which are fully exposed to wind and wave action, solutions have been proposed where the riser is terminated below the surface at a depth not interferring with surface vessel's draught. Although this method does not involve a connection to be performed at the exposed surface, such solutions are troubled by a limited accessability for persons combined with the problem of making a dynamic connection between two moving parts.

Summary of the Invention

The object of the present invention is to provide a method and a system reducing the problems which arise when making a connection to an offshore loading facility in adverse weather, so as to improve the regularity, simplify the system and to reduce the investments.

The method according to the invention of loading a shuttle tanker with hydrocarbons from a seafloor pipeline is characterized by dynamically positioning the shuttle tanker over a seafloor terminal at the end of the seafloor export pipeline from the production/storage platform. From the shuttle tanker there is lowered a flexible riser carrying at the lower end a riser package which will dock onto the seafloor terminal. The length of the approximately vertical riser pipe will be actively motion-compensated to cancel out vertical vessel responses to wave action.

Each shuttle tanker is carrying its own flexible riser system, stored on deck during transit, which will be deployed from the surface to dock onto the seafloor terminal, as opposed to connecting the tanker to a surface-protruding riser pipe. By carrying out the connecting

operations at the seafloor an expensive offshore loading surface facility is eliminated. Further, the system regularity will be improved.

The seafloor pipeline is conducted so far from the production platform to the seafloor terminal, that the loading of the shuttle tanker can be carried out safely. The simplified and less expensive offshore loading facility represented by the seafloor terminal, enables utilization of several such facilities, which makes simultaneous or overlapping loading of several tankers possible, whereby continous loading is made possible.

When a shuttle tanker arrives on location offshore, it will take optimum position above the seafloor terminal by reference to the fixed production platform, and maintain optimum position and heading by the dynamic positioning (DP) control system. When the position of the shuttle tanker has been locked on to the seafloor terminal by the DP system controlling the thrusters and the main stern controllable pitch propeller, the riser will be deployed and lowered to the seafloor terminal. The riser will preferably be a continous flexible pipe, and will during transit be stored on a drum on the tanker deck.

The flexible riser will be lowered in a controlled way, and its lower end will be connected to the seafloor terminal. Integrated in this coupling operation are also electrical and hydraulic connections associated with control functions at the seafloor terminal. Thereby it is possible to operate an isolating valve at the seafloor terminal, enabling flow control of the hydrocarbons under pressure in the seafloor pipeline. The isolating valve is of the fail safe type which will close by spring return in case of loss of hydraulic pressure.

Prior to disconnection, the riser must be flushed for the removal of hydrocarbons. The flushing will be done after closure of the isolating valve by supply of a cleaning fluid displacing the crude, preferably from the lower riser end.

During the controlled lowering of the riser the lower riser end will be positioned by thrusters or water jets controlled from a similar riser DP system using the underwater navigation system for position reference. Static riser deflections from constant loads caused by currents will be sensed by the underwater navigation system at the lower riser package and will be fed intc the DP system of the tanker, moving the tanker until the average position of the lower riser package is approximately vertically above the seafloor terminal. Residual dynamic motions of the lower riser end will be sensed by the underwater navigation system, and will be compensated by the lower riser package thrusters or water jets, controlled from the riser DP system.

The lower riser package will in addition to thrusters or waterjets and the underwater navigation system include a riser connector and a reentry cone with mechanical latches matching a corresponding guide cone on the seafloor terminal.

Additional features and advantages of the present invention will be found in the following description, reference being had to the drawings.

Brief Description of the Drawings

Fig. 1 is a side view, partially in section, and shows schematically a seafloor pipeline with two seafloor terminals, a fraction of a shuttle tanker at the surface and a flexible riser pipe supported from the tanker deck by a motion compensating device and carrying at the lower end a lower riser package connected to one of the seafloor terminals. Note that the dimension of the seafloor equipment is exaggerated relative to the shuttle tanker shown.

Fig. 2 shows on a larger scale the seafloor terminal and the lower riser package at the lower riser end.

Fig. 3 shows the shuttle tanker with the storage drum for the riser pipe and its guiding system along the hull side.

Fig. 4 shows schematically an alternative device assuring constant riser tension and compensating for vertical vessel motions.

Fig. 5 is a cross-section of the flexible riser pipe with an internal coaxial flushing line, and control lines arranged in the riser wall.

Fig. 6 is a secticnal side view of the lower riser end showing the terminaticn of the coaxial flushing pipe.

Fig. 7 is a cross-section taken along the line VII-VII of Fig. 6. For the sake of simplicity, the control lines are omitted from Fig. 7.

Disclosure of Preferred Embodiments

The permanent field installation of the system according to this invention is constituted by a crude export pipeline 1 conducted along the seafloor 2 from a production/ storage platform, which can either be a fixed platform or a subsea production system.

The export pipeline 1 is connected to i.e. two seafloor terminals 3 and 4 located at a safe distance from the producticn/storage facility.

The seafloor terminal 3 can be seen on Fig. 2. It consists of a conductor pipe or pile 5, drilled or piled into the seafloor 2, upon which is mounted a tubular diverter with three outlets 6, 7 and 10. The outlets 6 and 7 have flanges for connecticn to the export pipelines 1 and 9, respectively. The export pipeline section 9 connects the two seafloor terminals 3 and 4.

From Fig. 2 it can be seen that the pile 5 supports two guide structures 5a for the exprt pipelines 1 and 9. Connecticn of pipeline 1 to the flange 6 can be accomplished by means of a wire 1c attached to a sled 1d at the end of the pipeline 1. By a diver the wire 1c will be conducted around the guide sheave 1e, and up to an installation vessel at the surface. By pulling the wire 1c, the pipeline 1 with the sled 1d will be pulled into the guide structure 5a

untill a hydraulic connector 1f faces the flange 8. Thereafter the diver will attach hydraulic hoses (not shown) to the connector 1f to activate the latter for the locking thereof over the flange 8. When the connection is made, the wire pull will be increased untill the wire is released from the sled 1d and can be pulled up to the surface. At the top of the tubular pile 5 there is mounted a frame foundation 12 supporting two guide posts 13 with a reduced diameter at their upper ends.

The seafloor terminal 3 also incorporates a retrievable riser base 16, consisting of a hydraulic connector 18, an isolating ball valve 17 with hydraulic operator 17' and two guide arms 18' extending laterally from the connector 18 and supporting at either outer end a guide funnel 20 with conical entrance 20' at the lower end. To the guide funnels 20 there are also attached brackets 14 for hydroacoustic transponders 15.

The guide funnels 20 are entered ontc the guide posts 12, and the connector 18 connects the riser base 16 with the isolating valve 17 to a flange hub 11 on the pipe outlet 10. The connector 18 will normally attach the riser base 16 to the rest of the seafloor terminal 3, however, the riser base 16 can, if necessary, be retrieved to the surface for maintenance by opening the connector 18.

The non-fixed parts of the system according to this invention consist of a shuttle tanker 30 supporting a riser pipe 32 terminated at its lower end by a lower riser package 200, shown on Fig. 2. The lower riser package 200 comprises a transition piece 201 made of steel with a flange 202 at the lower end. On this there is mounted a control system housing 203, to which are attached electically driven thrusters 204. The thruster propellers 204 are controlled from the riser DP system to stabilize the position of the lower riser package 200 prior to and during docking to the seafloor terminal 3 at the seafloor 2. A jumper hose 201' running from the transition piece 201 to

the control system housing 203, contains electric control lines and electric and hydraulic power supply lines.

Underneath the control system housing 203 the riser 32 is extended by a spool piece 205, the purpose of which is to separate the hydro-acoustic sensors 206 from the propellers 204, said sensors being mounted on retractable arms 206' attached to two horizontal arms 207 carrying two guide funnels 208 at their outer end. The inner ends of the arms 207 are attached to the spool piece 205 and are also carrying a structural frame or cage 209. Within the cage 209 there is mounted a hydraulic connector 211 serving to connect the spool piece 205 at the end of the riser 32 to a flange 19 at the riser base 16. Hydraulic cylinders 210 will jack the connector 211 down over the flange hub 19. The sensors 206 are retractable as indicated in Fig. 2, in order to minimize the lateral dimensions of the lower riser package 200 when it is deployed from or retrieved to the tanker 30.

The upper end of the flexible riser 32 will under transit of the tanker 30 be coiled on a storage drum 33 (Fig. 1 and 3) or 146 (Fig. 4). When the riser 32 is coupled to the valve installation at the seafloor, the connection between the riser 32 and the tanker 30 must contain a form of compensation of relative motion between the ocean floor 2 and the ship 30. Two alternative versions of such a motion compensation system is schematically shown in Fig. 3 and 4, respectively.

In the embodiment illustrated in Fig. 3, the storage drum 33 for the riser 32 is used to execute the motion compensation. The drum 33 is thus provided with an active control system (not shown) that provides constant tension in the riser 32 even by relative motion between ship 30 and the ocean floor 2. The drum 33 can be placed near the ship's centre plane, and the riser 32 is guided through an open duct (not shown) in the hull. This implies an expensive modification of a tanker, but will be very favourable if the ship is to be able to turn more than 360° around the

riser 32. A less expensive modification of the tanker is implied if the drum 33 can be placed by the ship-side as indicated in Fig. 1. The riser 32 will then be guided down along the side of the ship 30 and hereunder be protected by a guide structure 31 which consists of a steel frame including perforated plating. This design will protect the riser 32 against extreme forces from waves (slashing) and mechanical impacts. In the lower end of the guiding system 31, the control system 39 is provided, the function of which is to prevent the riser 32 from rubbing against the bilge of the ship 30 or against the guiding frame 31. This control system has a guide on vertical rails (not shown) along the ship-side, whereby the riser 32 and the lower riser package 300 can be hoisted all the way up on the deck of the ship close to and below a foundation 34 for the drum 33. As soon as the riser package 300 is lowered through the guide 31, the control system 39 will follow. It can be locked in its lower position.

The foundation 34 for the drum 33 rests on a frame 35. The drum 33 is rotatably stored on the frame 34 by means of suspension 36. For elimination of torsion in the riser 32, the drum 33 can be rotated in its suspension 36 by a motor (not shown) which can be controlled by directional information from the ship's dynamic positioning system.

For distribution of the riser 32 on the drum during spooling, there is provided a special spooling mechanism 37. The riser upper end is passed to the drum shaft and connected to a swivel joint (not shown). From the swivel joint an elongation 40 is provided from the riser 32 axially out from the drum 33 and down to a smaller drum 38. The intention of this drum 38 is to spool on an off a shorter length of flexible tubing (not shown) to compensate for the drum rotation on the frame 34 by directional change of the ship.

In other words the smaller drum 38 has the function of a heave or motion compensation system for the riser so as to compensate for the difference in riser length related to a fixed vertical reference value in the overall dynamic

positioning system of the tanker. The smaller drum 38 includes means for the controlling thereof based on signals generated in the dynamic positioning system.

In another embodiment of the motion compensation system, shown in Fig. 4, the upper end of the riser 32 can be disconnected from the storage drum 146 after the lowering of the riser, whereafter the upper end will be connected to a motion compensator 140. This connection is provided by means of a hydraulic coupling 136, which can be a "Cameron Collet Connector", and which connects a transition piece 133 with a swivel 137. The transition piece 133 is connected to the upper end of the riser 32 and is also connected to a fork-shaped, horizontal support 134, which is positively guided in the vertical direction in a guide 135. The swivel 137 allows the tanker 30 to rotate due to a change in wind- and current-direction without implying torsional loads on the riser 32. To eliminate torsion in the riser as a consequence of the minor friction that will occur in the swivel 137, this can be equipped with a small electrical motor that is regulated by the directional information from the dynamic positioning system.

A steel wire 138 is connected to the swivel 137, and the wire is passed around a guide sheave 139 to the motion compensator 140. The motion compensator 140 is to be actively controlled based on information from the vertical reference unit in the dynamic positioning system. As indicated on the drawing, the motion compensator 140 is shaped as a sheave. Such motion compensators are known and marketed among others by Vetco, Ventura, California.

For further transport of hydrocarbons, a loading arm - consisting of two tubes 141 and 142 - will be connected to the top of the swivel 137. By means of three swivels or joints 143a, 143b resp. 143c, the tubes are connected to each other and with the riser 32 and a conduit 148 in the tanker. This loading arm will compensate for relative vertical motion between the riser 32 and the tanker 30.

The middle link 143a in the loading arm is positively

guided in an arch-shaped guide 144 to absorb side-forces which the loading arm will be subjected to because of the ship rolling and wind-forces. The joints 143a-c can be so called FMC-joints, i.e. joints manufactured by the well known Food Machinery Corporation, Houston, U.S.A.

The guide 135 for the support 134 is assembled in a tower structure 145, which also carries the motion compensator 140 and storage drum 146 which is used for storage of the flexible riser 32 when the tanker vessel 30 is in transit.

In Fig. 4 the riser 32 is shown extending through a well 29 in the tanker 30. Such a well can be closed by using hatches incorporating locking bolts when the vessel is in transit. On the tanker weather-deck the well 29 will be covered by a metal grate.

At the upper end of the riser, hydraulic lines 101 and electrical cables 102, 103 (see Fig. 5) will be passed out through the side of the transition piece 133 and be attached to pipes or cables (not shown) running along loading arms 141 and 142.

By connecting the riser's lower end to the flange 19 on the ball valve 17 a coupling of the control lines and control cables for operation of the ball valve 17 and the hydraulic coupling 18 will also be obtained.

A section through the flexible riser 32 is shown in Fig. 5. The wall 100 of the riser can be made up of several layers of different materials, for example reinforced plastic. Such a flexible riser made from reinforced plastic is known and is marketed by Coflexip, France. The previously mentioned hydraulic lines 101 and electrical cables 102, 103 for resp. supply of electrical power and transmission of signals necessary for operation of thrusters, valves etc. in the riser package 200 and in the coupling section 3, can be incorporated in the wall 100.

Inside the flexible riser 32 there is concentricly assembled smaller pipes 106, which for example can consist of "Rilsan"-plastic. The purpose of the pipe 106 is for

it to act as a flushing line for supply of flushing fluid to the riser 32. Normally, hydrocarbons will flow up through the riser in the compartments 105 and 107. Upon termination of the loading operation any remaining hydrocarbons in the compartments 105 and 107 will possibly cause pollution of the ocean or pose a fire hazard on board the tanker 30, unless they have been flushed out of the riser 32 prior to its detachment from the coupling assembly 3 on the seafloor 2. Such flushing of the riser can be accomplished for example by injection of water or inert-gas (depending on whether the hydrocarbons consist of crude oil or gas) from the tanker 30 down through the flushing tube 106 and up through the annulus 105.

When rolling up the riser 32, the inner flushing tube 106 will not remain concentric, which in turn will change the length of the tube in relation to the riser. The flushing tube will be axially displaced within the riser 32. In Figs. 6 and 7 it is shown that for this reason flushing tube 106 has been passed concentricly through the riser 3 at its lower end by use of a cross 108, which is fixed to the flushing tube 106 and has longitudinal guide slots 109 in the wall 100 of the riser.

Instead of forcing flushing fluid down through flushing tube 109 under pressure, it is possible to remove the hydrocarbons by suction through the annulus 105 by use of an ejector at the riser's upper end. The flushing tube 106 would in that case be omitted and replaced by a remotely controlled valve (not shown) in the riser package 200 to allow sea water to enter the riser's lower end when the hydrocarbons are removed at the upper end.

The procedure involving hook-up, operation and disconnection of the loading system will now be described.

The tanker 30 will navigate to an approximate position over the hook-up assembly 3 on the seafloor 2 by use of for example a hyperbola navigation system (Decca or Pulse 8).

At that point, the vessel's dynamic positioning system will take over control of the vessel's position by using

information from the transponders 15, which for example could be of the Simrad-type. The vessel will thus be guided to the most favourable position with respect to the hook-up assembly 3 for attachment of the riser. The drum 33 will thereafter be activated such that the riser 32 is unrolled and lowered down through the guide structure 31.

During the initial phase of the lowering of the riser, i.e. when the lower end of the riser 32 with its coupling means 211 is lowered through the top layers of the sea, i.e. the layers which are heavily influenced by the wind and the wave actions, the heave compensator is disengaged in a controlled manner so as to allow the lower end of the riser to drop through the wave-influenced layers of the sea. Thus, the lower end of the riser 32 will rapidly sink through said layers to minimize the risk of being influenced by the wave forces.

The riser 32 itself will be guided by the guide mechanism 39 to its lowest position, where it will be locked to the vertical rails alongside the vessel-side. The riser 32 will then be lowered further towards the coupling structure 3 on the sea floor 2 until the lower riser package 200 is positioned approximately 20 metres above the coupling structure or hook-up assembly 3. The active motion compensating system for the drum 33 will then be activated such that the lower riser package 200 is kept vertically in position. At the same time, the sensors 206, which can be Simrad-sensors, pick up the signals from the hydro-acoustic transponders 15. On the basis of this information, the vessel's dynamic positioning system can control the propellors 204, such that the lower riser package 200 is placed in the optimum position approximately immediately over the hook-up assembly 3 and maintained in position within given limits in the horizontal plane.

Thereafter, the flexible riser 32 will be lowered under continuous control until the guide posts 13 enter the guide sleeves 208 and are hydraulicly locked to these by the use of lock pins (not shown), which are operated by a hydraulic

actuator 208'.

The last phase of the lowering, i.e. when the riser package 200 is ready for engagement with the coupling structure 3, can be carried out by controllably disengaging the heave compensator system for the drum 33. This will result in a dropping or rapid sinking of the riser pack onto the coupling structure. By using the hydraulic cylinders 210 the coupling 211 will be pushed down until it meets the flange 19 and lock to this flange by hydraulic operation from the deck of the vessel 30. Thereafter hydraulic pressure supplied from the vessel 30 through channels in the coupling 211 and the flange 19 will open the ball valve 17 against the spring pressure in the operator 17'. The hydrocarbons will now flow from the pipe line 1 through the hook-up assembly 3 and through the flexible riser 32 and into the tanker 30.

If continuous loading is desired, two tanker vessels can be used. Before the first vessel has finished the loading at the coupling structure 3, a second tanker will be positioned above the second coupling structure 4 and be connected to this in the same manner as described above. When the first tanker is fully loaded, the second tanker will open the ball valve on the coupling structure 4, while the ball valve 17 on the coupling structure 3 is closed from the first vessel. Thereafter, the hydrocarbons will be removed from the flexible riser 32 by use of an ejector pump (not shown) on the extension tube 140, at the same time as a remotely controlled valve (not shown) on the riser package 200 will allow sea water to enter at the same rate as the hydrocarbons are removed. When the flexible riser 32 is empty of hydrocarbons, the ball valve 17 will be closed by the spring pressure exerted by the operator 17' as soon as the valve opening hydraulic pressure supplied from the vessel ceases. Thereafter, the coupling 211 will be released from the flange 19 by application of hydraulic pressure from the vessel, and the hydraulic cylinders 210 will lift the coupling 211 from the flange 19.

Finally, the locking pins will be opened hydraulicly, such that the complete lower riser package 200 will be released from the guide pins 13 and thus from the coupling structure 3 on the sea floor.

The flexible riser 32 with the riser package 200 will now be lifted while the riser is guided by the guide mechanism 39 and distributed on the drum 33 by the distribution mechanism 37. When the lower riser package 200 reaches the bottom of the guide mechanism 39, this will be released hydraulicly and pulled up together with the lower riser package 200. This will be stored on deck of the tanker 30 under the base plate 34.

In case of damage to the flange 19 with sealing surfaces, the coupling 18, the operator 17' or the hydro-acustic transponders 15, the transistion piece 16 can be pulled up to the vessel 30 by using the flexible riser 32. In that case the coupling 18 will be released from the flange 11, whereas the coupling 211 is not released, but remains attached to the flange 19 and is used to lift the transition piece 16.

Patent Claims

1. A method for loading a tanker (3) with oil or gas from a submarine conduit (1), wherein the tanker is positioned dynamically above a coupling structure (3) connected to the conduit (1), and wherein a riser pipe (32) is lowered from the tanker, the lower end of said riser (32) carrying a coupling means (211) which is coupled to the coupling structure (3), characterized in that the lower end of the riser (32) is positioned dynamically during the lowering and coupling operation by means (204) which are monitored by the dynamic positioning system of the tanker.

2. Method as claimed in claim 1, characterized in that the position of the lower end (204, 211) of the riser is controlled by the dynamic positioning system of the tanker during the controlled lowering of the riser, and that the lower end of the riser is precision regulated by a precision regulation system which is integrated in said dynamic positioning system.

3. Method as claimed in claim 1 or 2, characterized in that a motion compensation system for the riser is included in the dynamic positioning system.

4. Method as claimed in claim 1, characterized in that the dynamic positioning of the tanker and/or the lower end of the riser is carried out by means of signals from transponders (15) on the coupling structure (3).

5. Method as claimed in claim 4, characterized in that the riser (32) is flexible and can be reeled onto a drum (33, 146) on the tanker, a motion compensation system being implemented by reeling on or reeling off the flexible riser (32) on the drum.

6. Method as claimed in claim 5, characterized in that the drum (33) can be turned about the

axis of the vertical, downwardly extending riser (32) to avoid riser torsion, the turning being controlled by the dynamic positioning system of the tanker.

7. Method as claimed in claim 1, characterized in that the upper end of the flexible riser (32), when being connected to the coupling structure (3), is detached from the drum (146) and is connected to a constant force pulley (140) via a tension means (138).

8. Method as claimed in claim 1, characterized in that during the initial phase of the lowering operation, the lower end of the riser (3) carrying the coupling means (211) is dropped into the sea, so as to rapidly sink through the upper wave influenced sea level, the dropping action being induced by controllably disengaging the motion compensation system during said initial lowering phase.

9. Method as claimed in claim 1, characterized in that the lower end of the riser (3), which carries the coupling means (211) and which is dynamically positioned to be brought in a position ready for connection to the coupling structure (3) at the sea bed, is connected to the coupling structure (3) by controlled disengagement of the heave compensation system, the lower end of the riser (3) with the coupling means (211) thereby being connected to the coupling structure (3) by being dropped thereonto.

10. Method as claimed in claim 1, characterized in that a closing valve (17) in the coupling structure (3) is opened and closed as controlled from the tanker (30).

11. Method as claimed in any of the preceding claims, characterized in that the riser pipe (32) is flushed or evactuated for the removal of oil or gas prior to disconnection from the coupling structure (3).

12. Method as claimed in claim 11, characterized in that the flushing of the riser pipe (32)

is carried out by liquid or gas being supplied to the lower end of the riser pipe, the flushing liquid or gas being supplied under pressure.

13. Method as claimed in claim 10, c h a r a c t e r i z e d i n that the flushing is carried out by evacuation by means of an ejector at the upper end of the riser pipe, whereas sea water is supplied without pressure to fill the riser pipe (32) behind the oil or gas when this is ejected therefrom by the ejector, the sea water being supplied in response to the opening of a remotely controlled valve.

14. System for loading a tanker (30) with oil or gas from a submarine conduit (1) by a method as claimed in claim 1, c h a r a c t e r i z e d i n that the tanker (30) is equipped with a riser (32) which at its lower end carries coupling means (211), the tanker also being equipped with a dynamic positioning system for dynamic positioning of the lower end of said riser (3), that the submarine conduit (1) is connected to a coupling structure (3) for automatic coupling to the coupling means (211) at the lower end of the riser (32), and that the tanker comprises means for storing the riser (32) during tanker transit, means for controlled lowering of the riser (32) to the coupling structure (33) for the coupling thereto, means for loading oil from the submarine conduit to the tanker (3) and means for maintaining a constant tension in the riser (32).

15. System as claimed in claim 14, c h a r a c t e r i z e d i n that to the lower end of the riser (32) there is attached a riser package (200) comprising a coupling (211) for the riser (32) and guiding sleeves or tunnels (208) adapted to be engaged with guiding pins (13) extending upwardly from the coupling structure (3).

16. System as claimed in claim 14 or 15, c h a r a c t e r i z e d i n that the coupling structure (3) comprises a closing valve (17) which can be operated from the tanker (30) via hydraulic and/or electric control wires

(101, 102, 103) which are incorporated in the riser pipe (32) and are connected to the control wires in the coupling structure (3) upon connection of the riser pipe thereto.

17. System as claimed in any of the claims 14-16, c h a r a c t e r i z e d i n that the closing valve (17) is incorporated in its own intermediate piece (16) which is detachably connected to the coupling structure (3) and comprises a pipe piece (19), to which the coupling means (211) on the riser pipe (32) can be connected.

18. System as claimed in claim 15 and 17, c h a r a c t e r i z e d i n that the intermediate piece (16) comprises guiding sleeves or tunnels (20) for engagement with the guiding pins (13).

19. System as claimed in any of the claims 15-18, c h a r a c t e r i z e d i n that the riser package (200) comprises propulsion means (203, 204) for dynamic positioning of said package, said means being controlled by the dynamic positioning system of the tanker.

20. System as claimed in claim 14, c h a r a c t e r i z e d i n that the coupling structure (3) comprises transponders (15) for transmittal of signals to the dynamic positioning system.

21. System as claimed in claim 20, c h a r a c t e r i z e d i n that the riser package (200) comprises sensor means (206) for regulating the last phase of the lowering operation, said lowering operation being monitored by a precition regulation system, which is integrated in the dynamic positioning system of the tanker.

22. System as claimed in any of the claims 14-21, c h a r a c t e r i z e d i n that the riser pipe (32) is flexible and during transit is reeled on to a drum (33, 146) on the tanker.

23. System as claimed in claim 22, c h a r a c t e r i z e d i n that the means for maintaining a constant

tension in the riser pipe (32) comprises means for rotating the drum (32), which is rotatably mounted about the axis of the riser pipe for allowing moting compensation of the riser relative to the heave movement of the ship.

24. System as claimed in claim 14, c h a r a c t e r i z e d by a constant power pulley (140), which via a tension means, for example a wire (138), imparts a load to the riser (32) to maintain a constant tension in the riser pipe when this is connected to the coupling structure (3).

25. System as claimed in claim 14, c h a r a c t e r i z e d i n that the riser (32) comprises a flushing pipe (106) for the supply of liquid or gas to the lower end of the riser pipe (32) after the termination of the loading of oil or gas.

26. System as claimed in claim 25, c h a r a c t e r i z e d i n that the flushing pipe (106) is arranged concentricly within the riser pipe (32).

27. System as claimed in claim 25 or 26, c h a r a c t e r i z e d by an ejector at the upper end of the riser pipe (32) for the evacuation of remaining oil or gas, which is followed by water allowed to enter the lower end of the riser pipe (32) by remote control of a valve in the riser package (200).

1/6

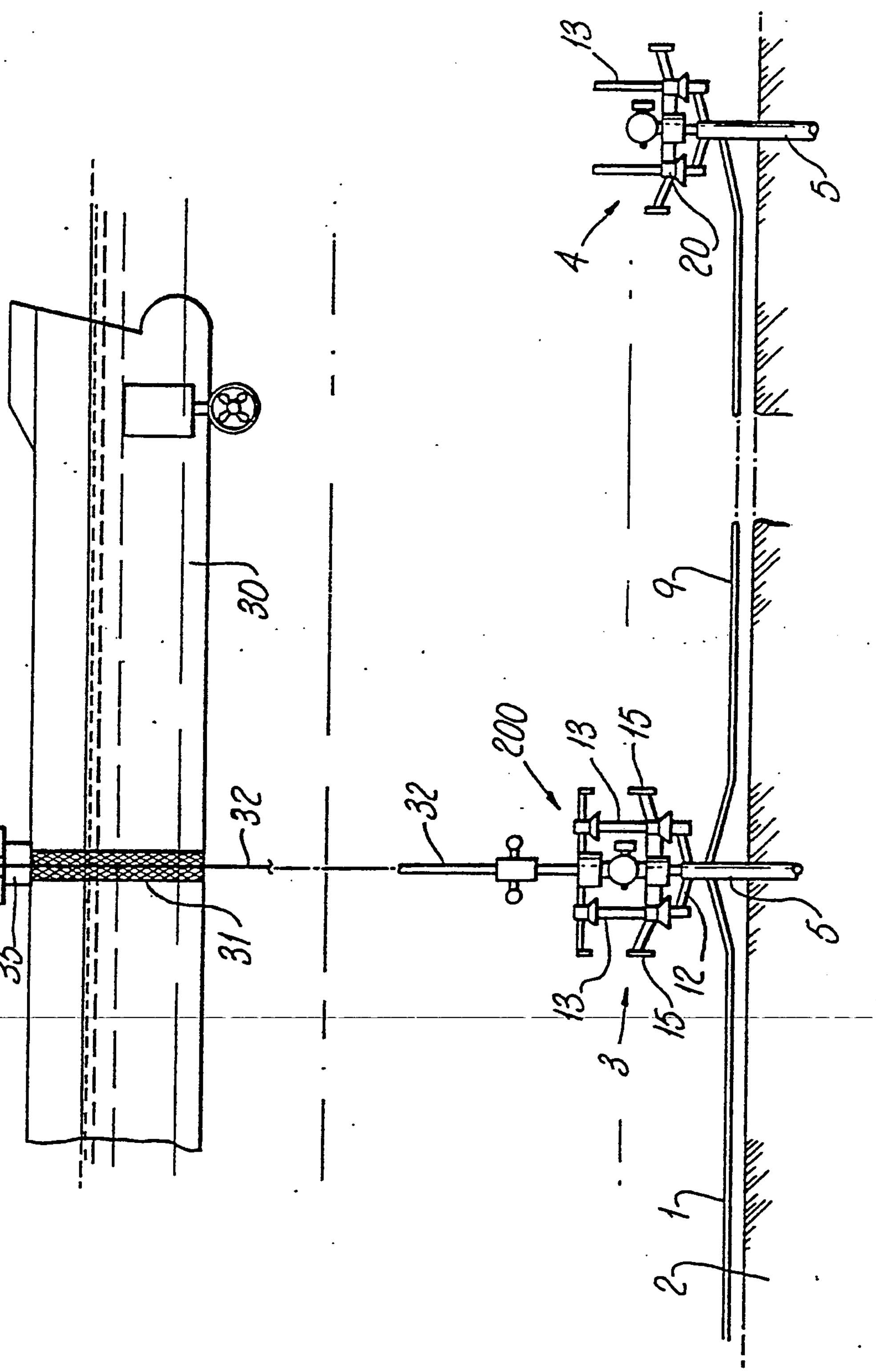
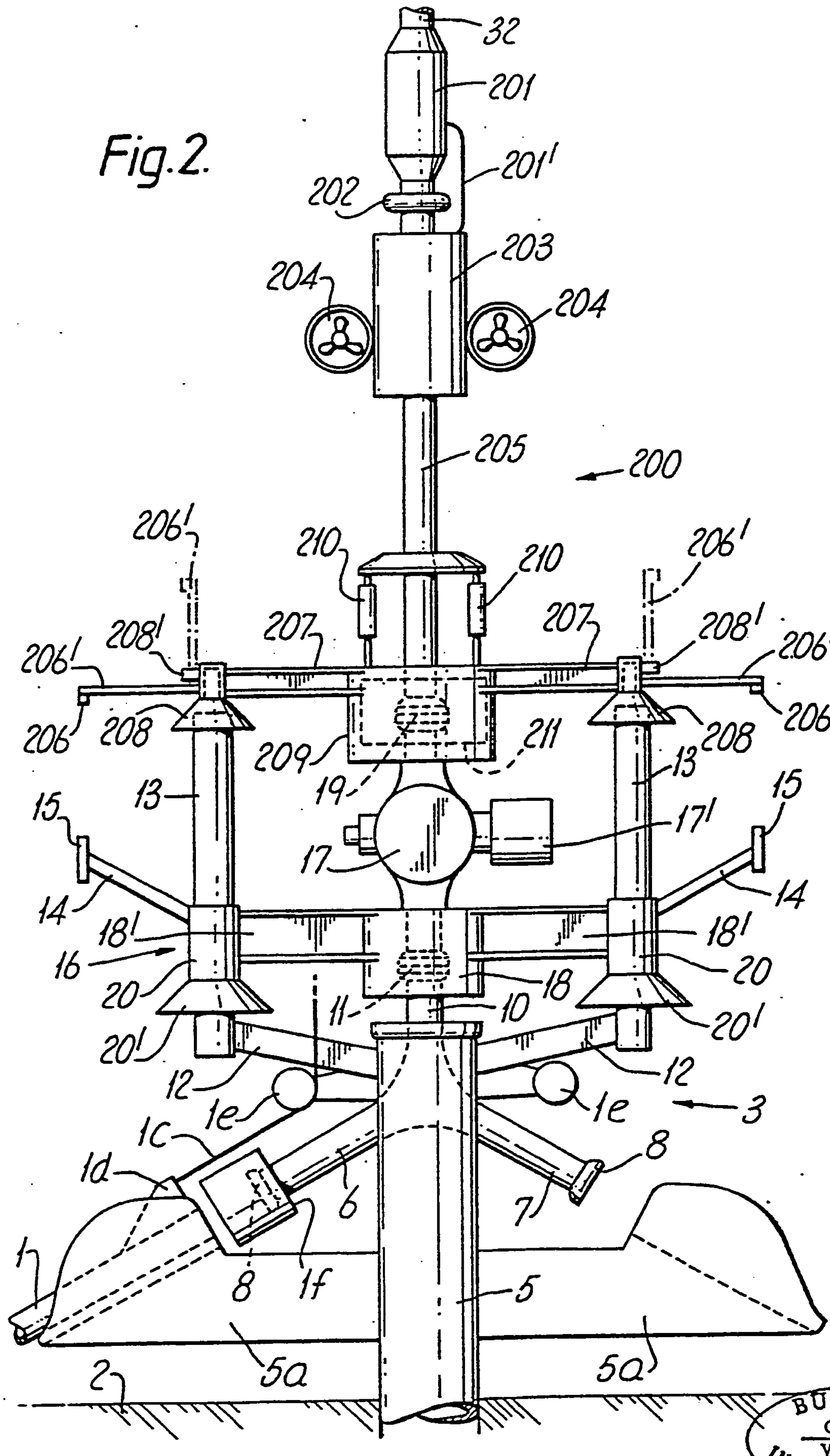


Fig.1.

Fig.2.


32
201
201'
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11
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20'
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12
12
1e
1e
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1c
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1d
6
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8
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5
5a
5a
2

Fig.3.

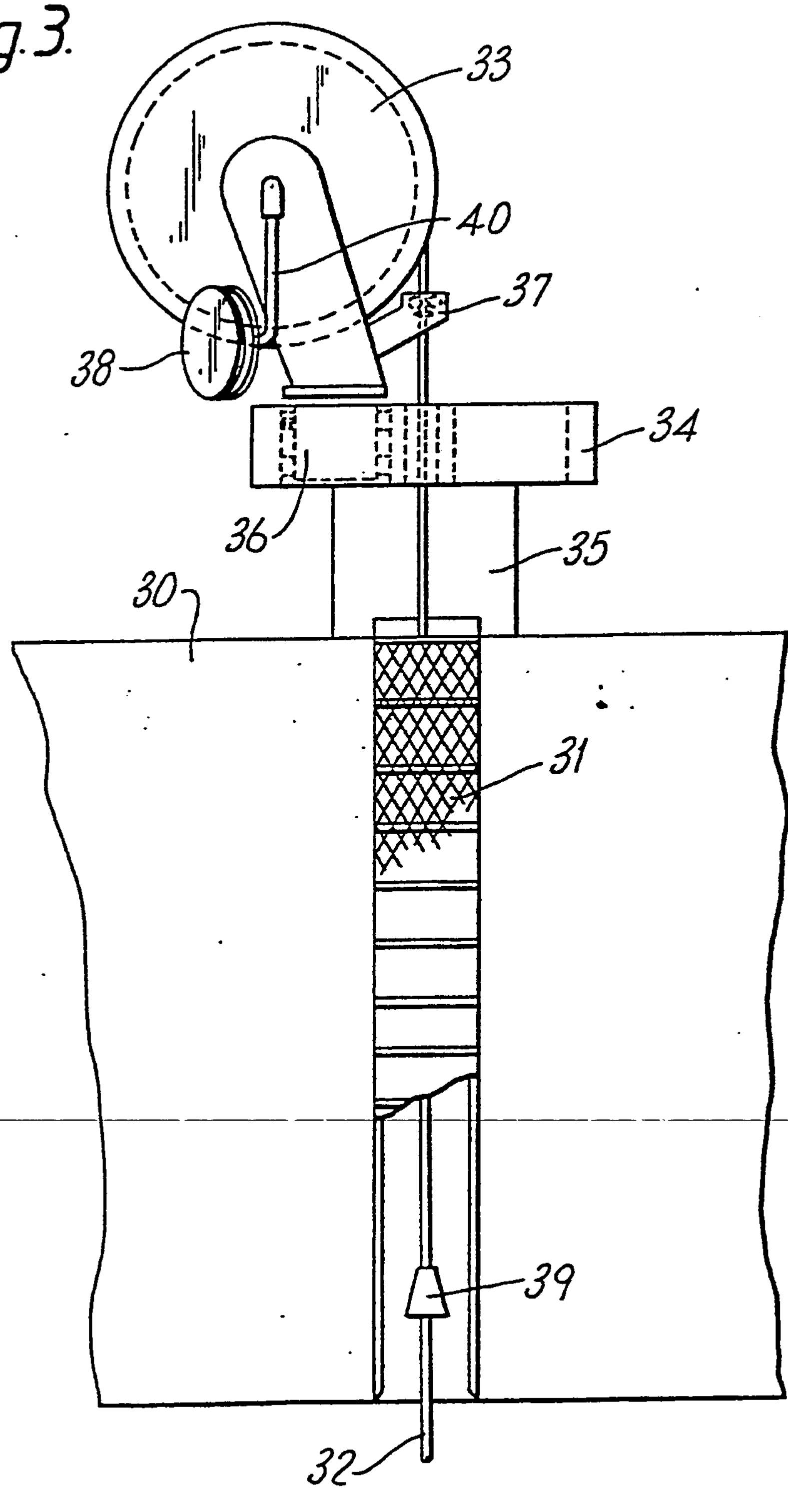
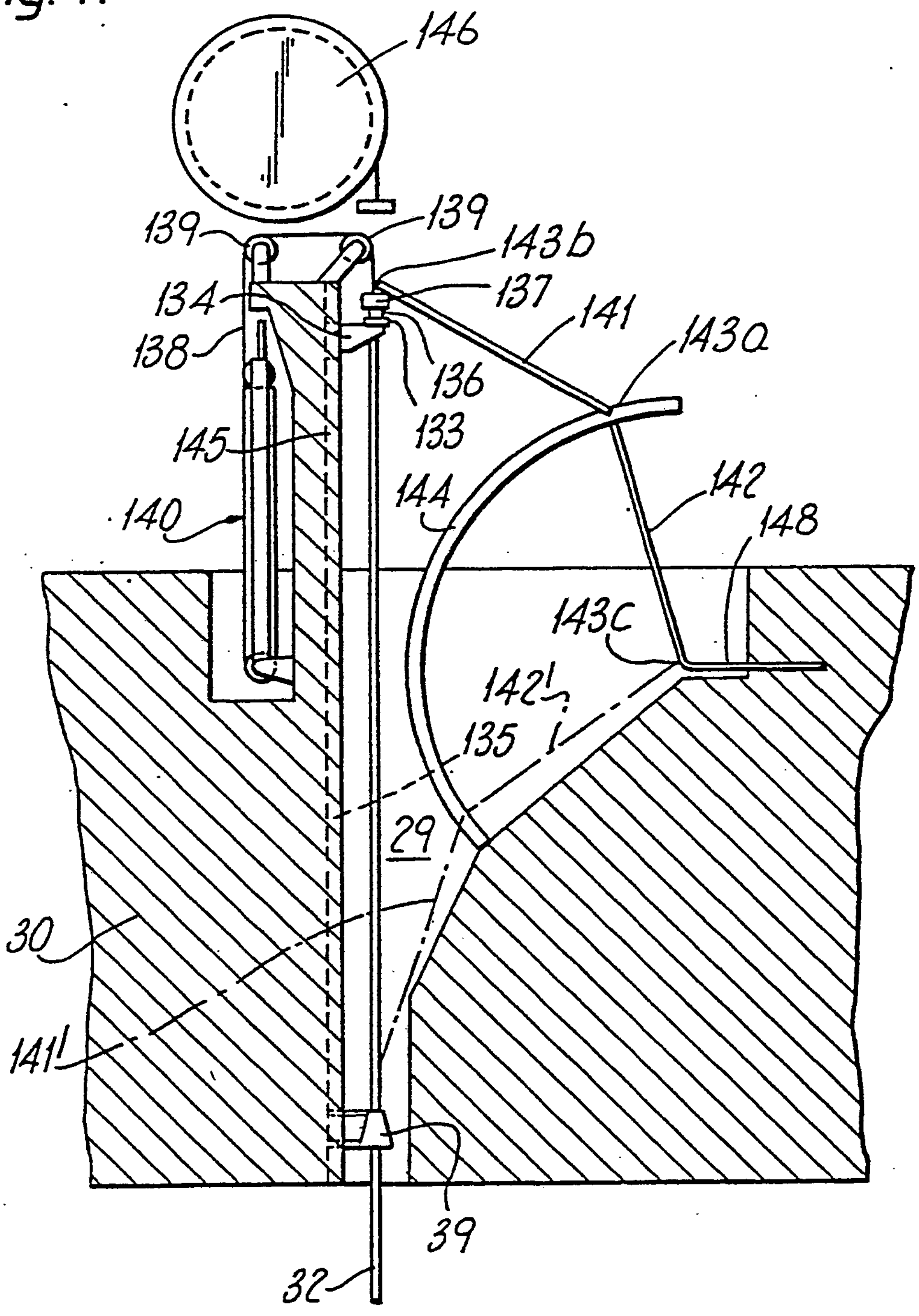


Fig. 4.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139
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143b
134
137
141
143a
138
136
133
145
142
144
148
140
143c
142'
135
29
30
141'
39
32

Fig.5.

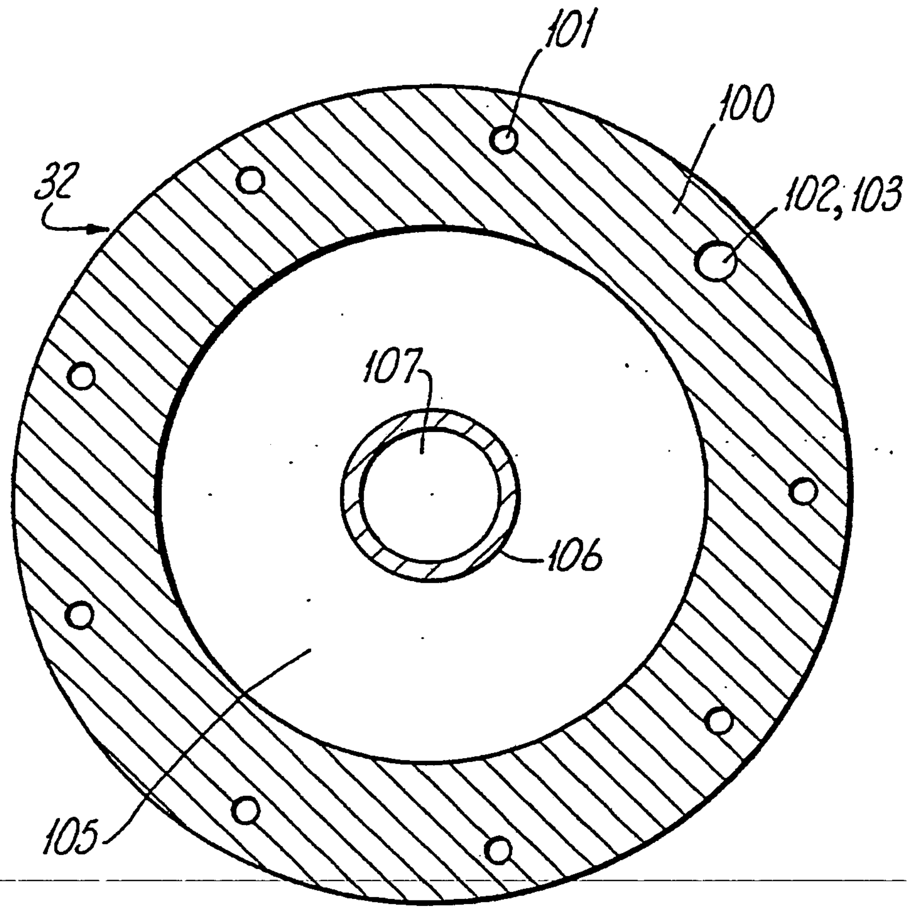


Fig.6.

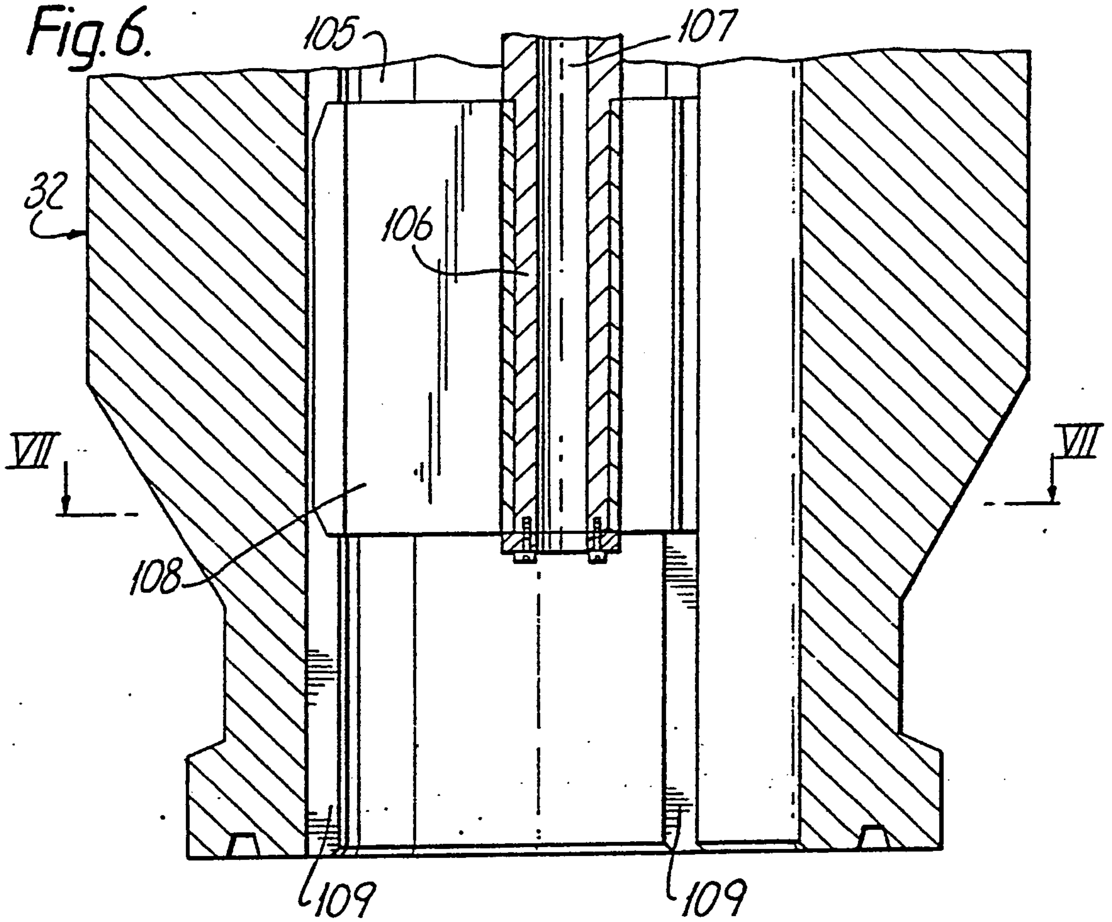
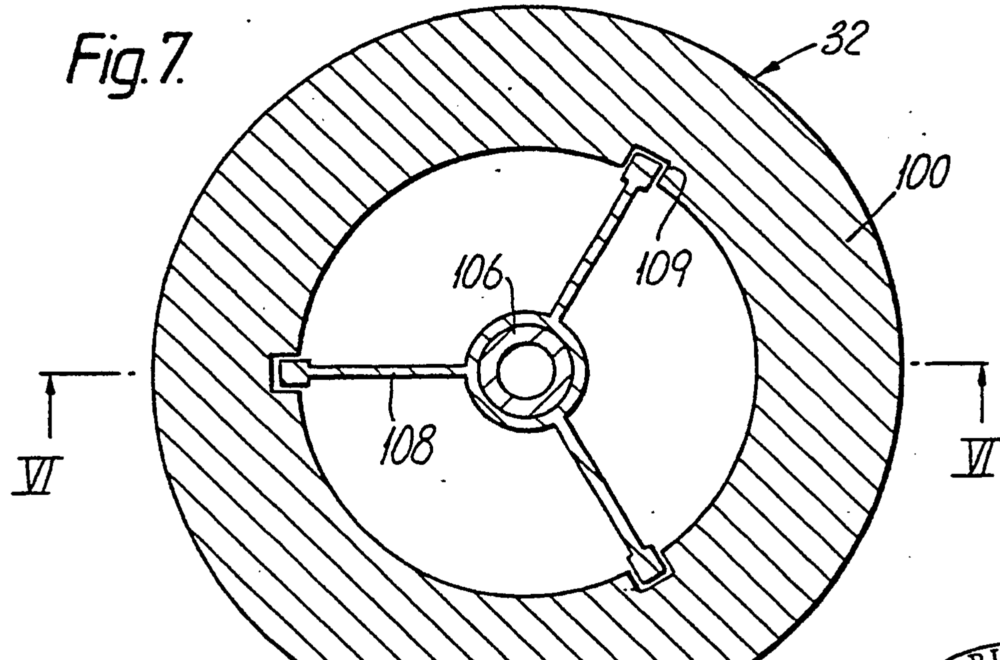


Fig.7.



INTERNATIONAL SEARCH REPORT

International Application No PCT/NO81/00019

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

B 63 B 27/34

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 2, 3	B 63 B 21/52, 27/20, 27/24, 27/30, 27/34, B 65 G 67/58–67/62, B 67 D 5/68, 5/70
US Cl	137:615; 141:387, 388; 214:12–15; 414:137–145

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	NO, B, 143 139 (ODD HAVRE) 18 July 1979 (18.07.79)	
X	NO, B, 139 042 (COFLEXIP) 10 May 1974 (10.05.74)	
X	DE, A, 2 505 721 (MANITZ, FINSTERWALD, GRÄMKOW) 8 January 1976 (08.01.76)	
X	GB, C, 1 436 739 (COFLEXIP) 26 May 1976 (26.05.76)	
X	GB, A, 2 001 033 (BUREZI, ROCHE, VIALLARD) 24 January 1979 (24.01.79)	
X	GB, A, 2 050 995 (LANGPAAP, WILKE) 14 January 1981 (14.01.81)	

* Special categories of cited documents: [15]

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
1981-12-14	-12- 17

International Searching Authority [1]	Signature of Authorized Officer [20]
Swedish Patent Office	Christer Jönsson